

Diesel Emission Reduction Act (DERA) & the Colorado Diesel School Bus Retrofit Program



COLORADO
Department of Public
Health & Environment

Ingrid Hewitson
Air Pollution Control Division
November 13, 2014

Diesel Exhaust Emissions - Toxicity

- ⦿ Diesel exhaust is an EPA-listed mobile source air toxic.
- ⦿ World Health Organization classified diesel exhaust as carcinogenic to humans.
- ⦿ Contains thousands of compounds:
 - More than 40 listed air toxics.
 - Several known carcinogens and many suspected carcinogens.

Toxic Air Contaminants in Diesel Exhaust:

- Acetaldehyde, acrolein, aluminum, ammonia, aniline, antimony compounds, arsenic, barium, benzene, beryllium compounds, biphenyl, bis-phthalate, bromine, 1,3-butadiene, cadmium, chlorinated dioxins, chlorine, chlorobenzene, chromium compounds, copper, cresol, cyanide, debenzofuran, dibutylphthalate, ethyl benzene, formaldehyde, hexane; lead, manganese and mercury compounds, methanol, methyl ethyl ketone, naphthalene, nickel, 4-nitrobiphenyl, phenol, phosphorus, POM (incl. PAHs), propionaldehyde, selenium compounds, silver, styrene, sulfuric acid, toluene, xylene isomers and mixtures, zinc

Diesel Exhaust and Children's Health

- Developing lungs more susceptible to exposure to air pollutants.
- Child respiratory rates are more rapid than adults':

Early childhood: 20-40 breaths/min.

Late childhood: 15-25 breaths/min.

Adults: 12-18 breaths/min.



Thus exposure is greater for children

Diesel Exhaust and Children's Health

- Diesel exhaust can aggravate or induce asthma and other pulmonary and cardiovascular conditions.
- PM2.5 levels inside school buses in Connecticut study were 5-10 times above the background levels (Wargo et al.(2002).
- Crankcase emissions (from under bus hood) is an “extremely strong source” of PM 2.5 in buses (Clean Air Task Force 3-city study '03 -'04).
- Idling buses have higher concentrations of emissions. (Wargo et al.(2002).
- However all vehicles emit pollution and school buses are the safest way for children to get to and from school.

Children's Exposure to Diesel Exhaust

- Exposure probably greatest inside school buses, but also at bus stops, other bus idling areas and in traffic (behind buses)
- Many children exposed for extended periods twice a day:
 - 20 days per month
 - 9 months/year
 - 10 to 12 years
- $2 \times 20 \times 9 \times 10 = 3,600$ exposures
- $2 \times 20 \times 9 \times 12 = 4,320$ exposures



Retrofit Goals

- Reduce in-vehicle exposures to children and drivers.
- Reduce exposures to children, drivers, parents, teachers from idling buses at neighborhood pickups and schools.
- Reduce exposure to general public in traffic, neighborhoods.
- Reduce fuel use via engine preheat technology (idling not necessary).

How Emissions Are Reduced: Three Cost-Effective Technologies

1. Engine pre-heaters

- Reduces idling time
- Saves ~ 1 gallon/bus/day of operation
- Cost: \$1,500 to \$3,200 each



Three Cost-Effective Technologies

2. Diesel oxidation catalysts (DOC)

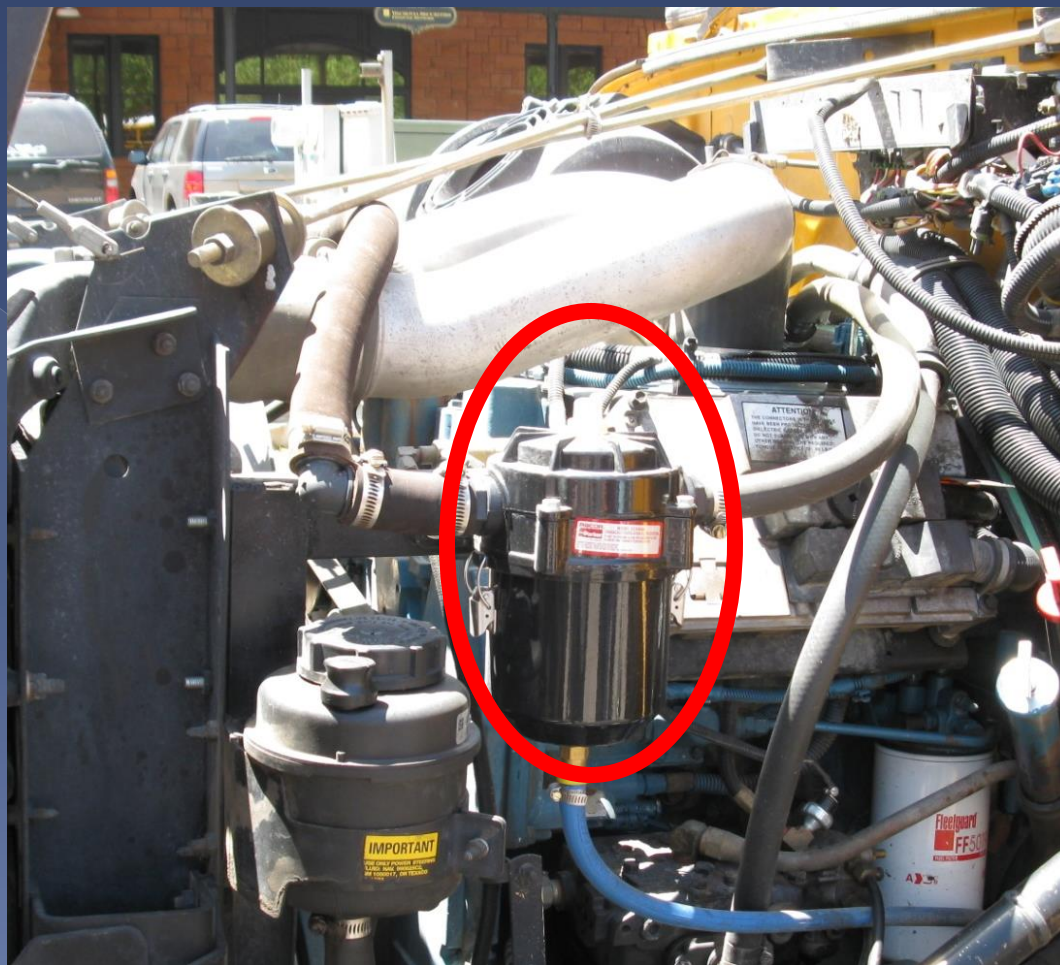
- Removes:
 - 20% of PM
 - 50% of HC
- Cost: \$1,000 - \$2,000 each



Three Cost-Effective Technologies

● Crankcase filtration (CCF)

- May reduce PM 2.5 by more than 95%
- Cost: \$400 - \$700 each, (plus replacement filter at each oil change: \$50)



Emission Reductions

- Estimated emission reductions through the use of engine pre-heaters only:
 - > 0.4 TPY PM
 - > 16.3 TPY CO
 - > 2.2 TPY HC
 - > 9.5 TPY NO_x
 - > 383.8 TPY CO₂
- Additional on-road reductions dependent upon VMT, weather, etc.



Air Sampling in Buses

● Pre- and post-retrofit:

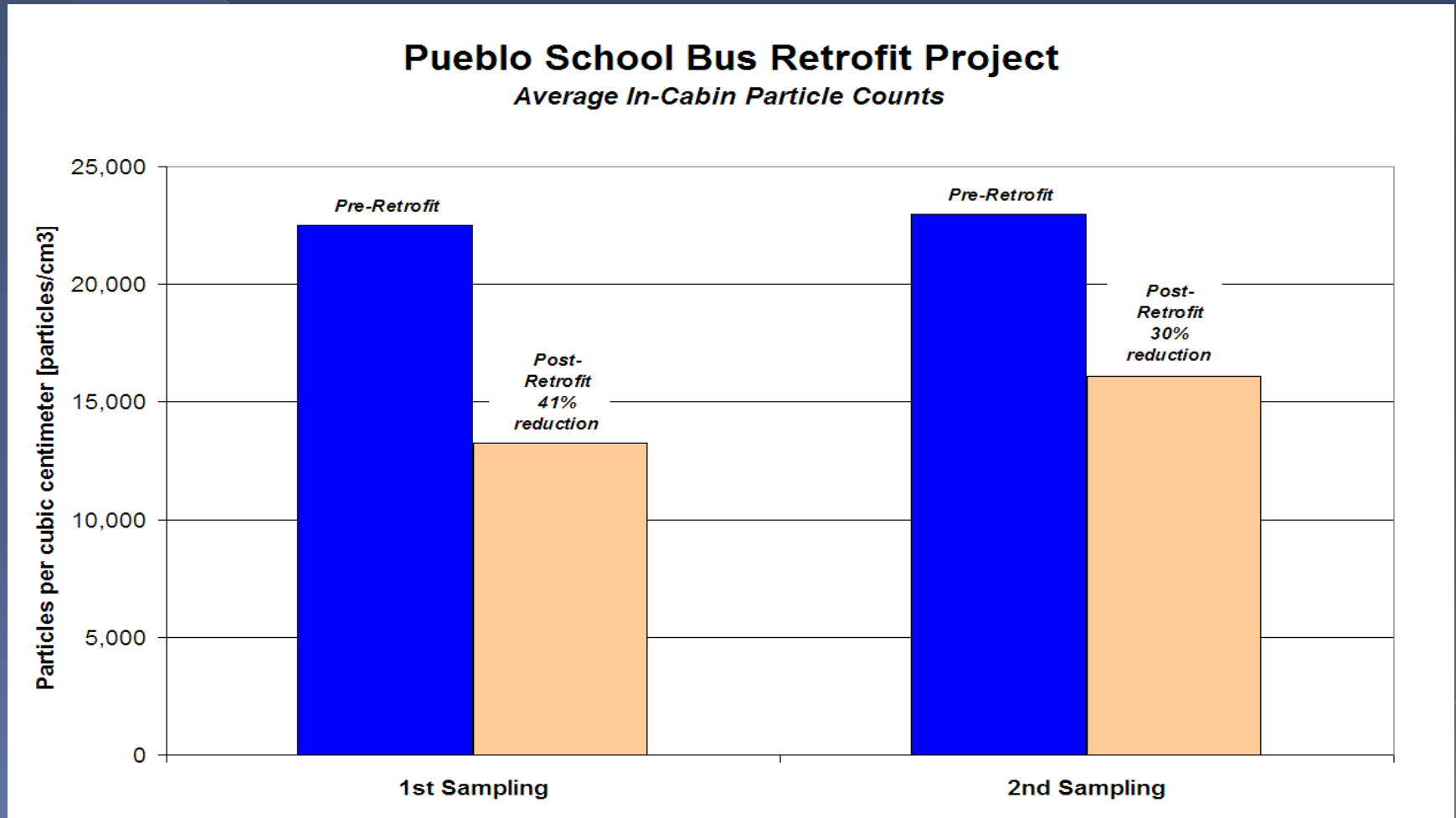
- Three buses ran three full routes each, before and after retrofits;
- Operated normally (opened/closed doors at each stop, etc.)
- Each bus completed same routes pre- and post-retrofit

● Fitted with:

- Small engine pre-heaters
- Donaldson Series 6100 DOC
- Racor 4500 crankcase filters

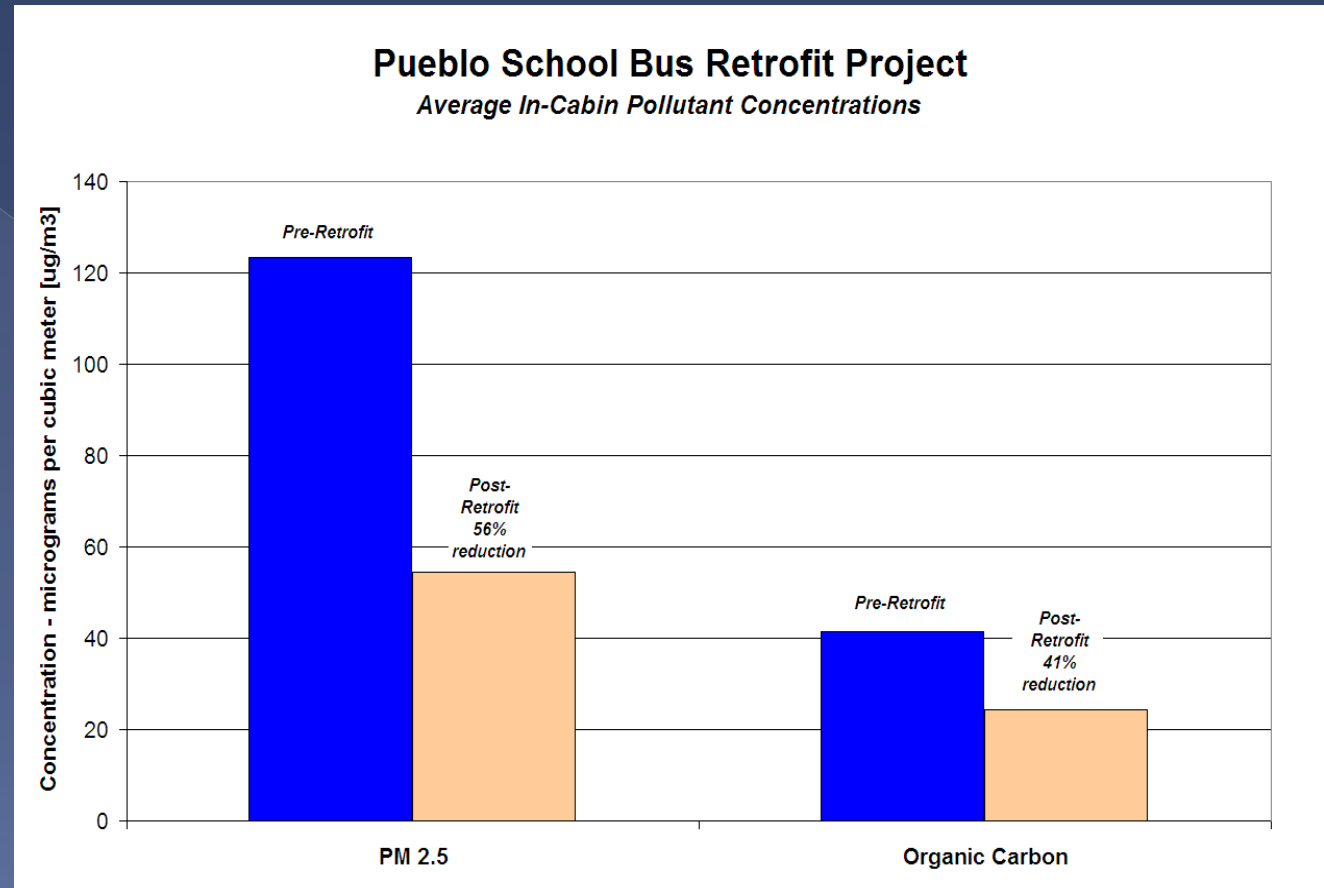
Average in-cabin pollutant reductions:

- Particle numbers reduced by 30%-41%



Average in-cabin pollutant reductions:

- PM_{2.5} mass reduced by 56%
- Organic carbon reduced by 41%



- Additionally, elemental carbon was reduced by 85% and Formaldehyde was reduced by 32%

How our program works

- Air Division's Planning & Policy and Mobile Sources programs partner with EPA, counties and school districts
 - Priority to retrofit MY 1988 – 2000 large route buses.
 - Funds are allocated according to criteria of:
 - Air toxics/diesel emissions in area
 - Environmental Justice needs
 - Interest
 - Education, outreach to school districts and fleets
 - Work with bus mechanics and drivers
 - Work with Clean Air at Schools, Engines Off (CASEO)
 - Promote reducing engine idling

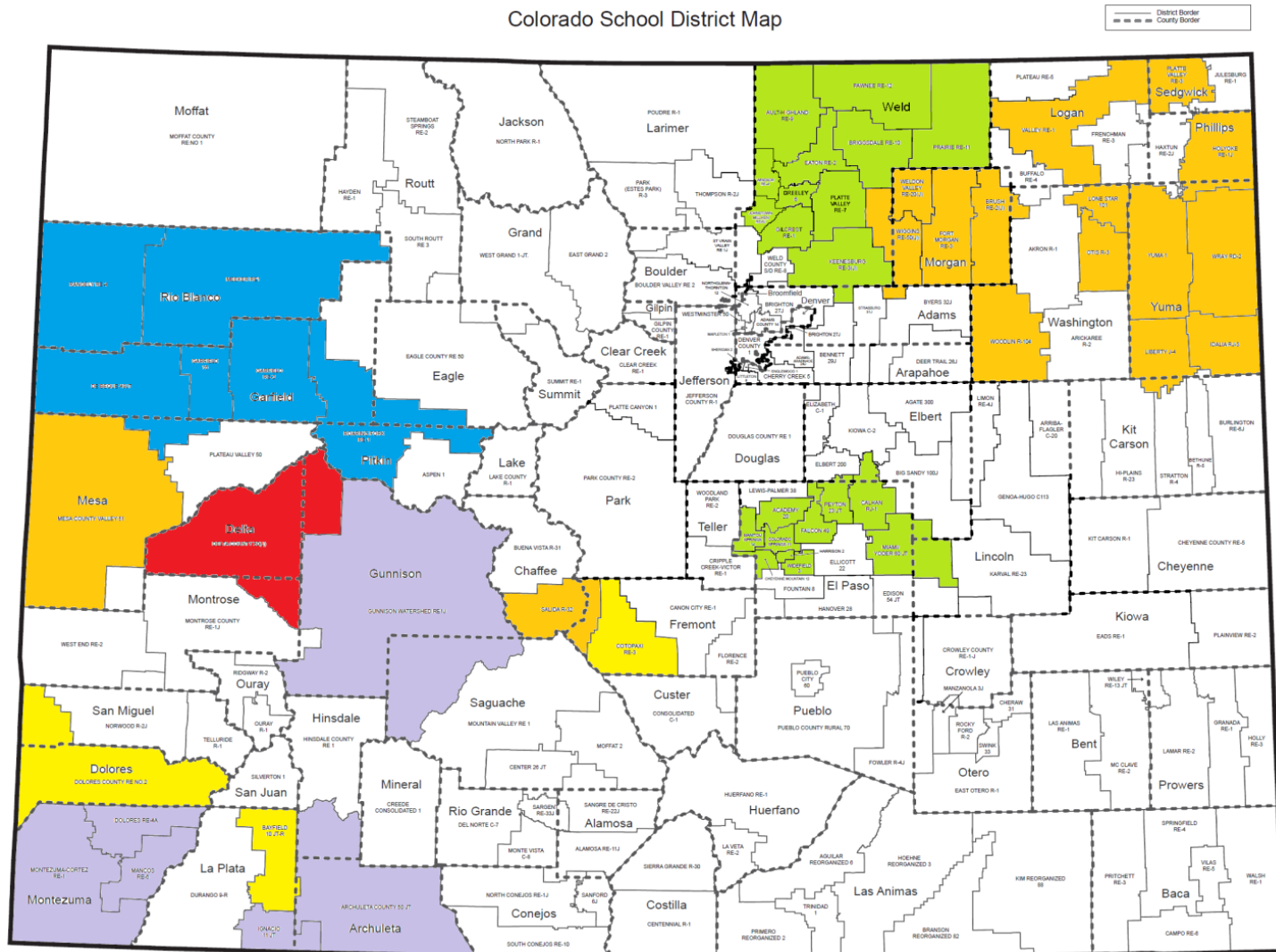
How our program works

- ◉ Quality Assurance - Major component
 - Assure that retrofit equipment is installed and functioning properly prior to paying for work
 - Department diesel engine experts personally inspect every bus.
 - Conduct follow up QA/QC and training to ensure components continue to operate correctly.
- ◉ Analysis and Reporting
- ◉ Tracking:
 - Participating districts
 - Emissions reductions

Our Progress:



Colorado School District Map



Program Benefits

- Significant emissions reduction
- Direct benefit to children's health
- Direct benefit to ambient air quality
- Allow fiscally constrained school districts to pursue this type of project
- Potential SIP credits
- Reduced idling and petroleum usage (resources and money)

Contacts

Colorado Clean Diesel Program

Ingrid Hewitson (303) 692-6331

Lisa Devore (303) 692-3117

Retrofit Quality Assurance

Dave Moreau (720) 252-7846

Raymond Elick (303) 744-2522

Doug Decker (303) 692-3126

EPA

Marisa McPhilliamy (303) 312-6965

Kyle Olson (303) 312-6002